

WHAT IS CLAIMED IS:

1. A manufacturing method of a semiconductor device, comprising the steps of:

5 making a device using nitride III-V compound semiconductors on one major surface of a single-crystal substrate made of a material different from nitride III-V compound semiconductors;

10 thinning said single-crystal substrate by processing the other major surface of said single-crystal substrate by lapping using an abrasive liquid containing an abrasive material of diamond abrasive grains and reducing the grain size of said abrasive material in plural steps; and

15 removing a strained layer produced on said other major surface of said single-crystal substrate during said lapping by etching said other major surface of said single-crystal substrate after lapping by using an etchant containing phosphoric acid or phosphoric acid and sulfuric acid as its major component and  
20 heated to 150 through 450 °C.

2. The manufacturing method of a semiconductor device according to claim 1 wherein said single-crystal substrate is thinned to a thickness not larger than 100  $\mu\text{m}$ .

25 3. The manufacturing method of a semiconductor device according to claim 1 wherein the surface of said device made on said one major surface of said single-

crystal substrate is covered by a protective film having a resistance to said etchant before said other major surface of said single-crystal substrate is etched.

5 4. The manufacturing method of a semiconductor device according to claim 3 wherein said protective film is a silicon oxide film, silicon nitride film or polyimide film.

10 5. The manufacturing method of a semiconductor device according to claim 1 wherein said other major surface of said single-crystal substrate is etched by immersing only said other major surface of said single-crystal substrate into said etchant.

15 6. The manufacturing method of a semiconductor device according to claim 1 wherein said single-crystal substrate is a sapphire substrate, spinel substrate, perovskite yttrium aluminate substrate or SiC substrate.

20 7. The manufacturing method of a semiconductor device according to claim 1 wherein said semiconductor device is a semiconductor laser using nitride III-V compound semiconductors.

25 8. The manufacturing method of a semiconductor device according to claim 1 wherein said semiconductor device is a FET using nitride III-V compound semiconductors.

9. A semiconductor device having a single-

Sub D83

D

crystal substrate made of a material different from  
nitride III-V compound semiconductors, and a device  
made on one major surface of said single-crystal  
substrate by using III-V compound semiconductors,  
5 comprising:

electrical connection to said device being  
made through a via hole formed in said single-crystal  
substrate.

10. The semiconductor device according to claim 9  
wherein said single-crystal substrate is a sapphire  
substrate, spinel substrate, perovskite yttrium  
aluminate substrate or SiC substrate.

11. The semiconductor device according to claim 9  
wherein said semiconductor device is a semiconductor  
15 laser using nitride III-V compound semiconductors.

12. The semiconductor device according to claim 9  
wherein said semiconductor device is a FET using  
nitride III-V compound semiconductors.

13. A manufacturing method of a semiconductor  
20 device having a single-crystal substrate made of a  
material different from nitride III-V compound  
semiconductors and a device made on one major surface  
of said single-crystal substrate by using III-V  
compound semiconductors, in which electrical connection  
25 to said device is made through a via hole formed in  
said single-crystal substrate, comprising the step of:  
forming said via hole by selectively etching

the other major surface of said single-crystal substrate by using an etchant containing as its major component phosphoric acid or phosphoric acid and sulfuric acid heated to 150 through 450 °C.

5 14. The manufacturing method of a semiconductor device according to claim 13 wherein an etching mask made of a first thin film of Cr, Ti or Ni and a second thin film of Pt, Pd or Au thereon is made on said other major surface of said single-crystal substrate, and  
10 said via hole is made by etching said other major surface of the single-crystal substrate using said etching mask.

15 15. The manufacturing method of a semiconductor device according to claim 13 wherein said other major surface of said single-crystal substrate is etched by immersing only said other major surface of said single-crystal substrate into said etchant.

20 16. The manufacturing method of a semiconductor device according to claim 13 wherein said single-crystal substrate is a sapphire substrate, spinel substrate, perovskite yttrium aluminate substrate or SiC substrate. 17. The manufacturing method of a semiconductor device according to claim 13 wherein said semiconductor device is a semiconductor laser using  
25 nitride III-V compound semiconductors.

18. The manufacturing method of a semiconductor device according to claim 13 wherein said semiconductor

device is a FET using nitride III-V compound semiconductors.

19. A manufacturing method of a semiconductor device having a single-crystal substrate made of a material different from nitride III-V compound semiconductors and a device made on one major surface of said single-crystal substrate by using III-V compound semiconductors, in which electrical connection to said device is made through a via hole formed in said single-crystal substrate, comprising the steps of:

making a hole as deep as 10  $\mu\text{m}$  or more but not reaching said one major surface of said substrate by selectively irradiating laser light having a wavelength not shorter than 6  $\mu\text{m}$  onto the other major surface of said single-crystal substrate; and

making said via hole by etching said other major surface of said single-crystal substrate by using an etchant containing as its major component phosphoric acid or phosphoric acid and sulfuric acid heated to 150 through 450  $^{\circ}\text{C}$  so as to make said hole reach said one major surface.

20. The manufacturing method of a semiconductor device according to claim 19 wherein pulse laser light having the wavelength of 10.6  $\mu\text{m}$  from a  $\text{CO}_2$  laser is used as said laser light.

21. The manufacturing method of a semiconductor device according to claim 19 wherein said single-

crystal substrate is a sapphire substrate, spinel  
substrate, perovskite yttrium aluminate substrate or  
SiC substrate. 22. The manufacturing method of a  
semiconductor device according to claim 19 wherein said  
5 semiconductor device is a semiconductor laser using  
nitride III-V compound semiconductors.

23. The manufacturing method of a semiconductor  
device according to claim 19 wherein said semiconductor  
device is a FET using nitride III-V compound  
10 semiconductors.

add D10